2014

Fate of C and N from Dung Pats into Soil

Kenneth Evans

Ana Wingeyer
Instituto Nacional de Tecnología Agropecuaria

Martha Mamo
University of Nebraska-Lincoln, mmamo3@unl.edu

Pamela Sutton
University of Nebraska-Lincoln, psutton5@unl.edu

Jeff Bradshaw
University of Nebraska-Lincoln, jbradshaw2@unl.edu

See next page for additional authors

Authors
Kenneth Evans, Ana Wingeyer, Martha Mamo, Pamela Sutton, Jeff Bradshaw, Kent M. Eskridge, Matt Judkins, Jenna Beckmann, and Erin Hatch

Fate of C and N from Dung Pats into Soil

Kenneth Evans[1], Ana Wingeyer[2], Martha Mamo[1], Pamela Sutton[1], Jeff Bradshaw[3], Kent Eskridge[4], Matt Judkins[1], Jenna Beckmann[1], and Erin Hatch[1]
[1] Department of Agronomy and Horticulture, [3] Department of Statistics, [4] Department of Statistics, University of Nebraska-Lincoln, [2] Instituto Nacional de Tecnología Agropecuaria, Entre Ríos, Argentina

United States Department of Agriculture
National Institute of Food and Agriculture

Rationale

Change in grazing density can influences dung distribution patterns, with potential impacts on the abundance and frequency of dung beetles populations and nutrient cycling in grazing systems. The goal of this research was to quantify and characterize the fate of nutrient pulses from cow dung after deposition, and the associated effects of dung beetle activity. Mass and nutrient loss of dung, changes in soil nutrients below and around dung pats, and fluxes of greenhouse gases (GHGs) were monitored overtime. The results on soil nutrients are presented here and another paper by Evans et al. presents GHG fluxes.

Hypotheses

Dung beetle activity can affect the amount and timing of pulses of soil nutrients from decomposing dung pats.

- Dung pats exposed to dung beetle activity will exhibit higher peak pulses of N and C into the soil.
- Dung pats exposed to dung beetle activity will exhibit peak fluxes N and C at earlier days after application (DAA) of dung.

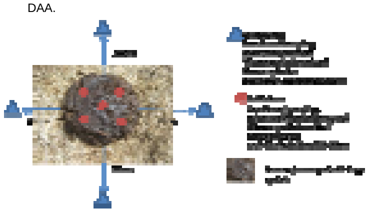
Materials & Methods

Site Description

Research was conducted at the University of Nebraska-Lincoln, Barta Brothers Ranch (42° 13'28.65"N, 99° 38'19.17"W) on subirrigated, sandy to fine sandy loam soils in the Valentine series.

Experimental Design and Treatments

- Three treatments were arranged in a repeated measurement RCB with 8 blocks and replicated during grazing season (sequential June and July experiments). June data is presented here.
- Treatments included artificially created 20 cm diameter pats from 1.5 L of homogenized beef cattle manure placed directly on the ground (BEETLE), inside a wire-mesh exclusion cage (NO BEETLE), and a no dung treatment (CONTROL).
- Soil samples were collected directly beneath the dung pat and 30-cm away from the dung treatments.
- Soil samples were collected at 1, 3, 7, 14, 28, and 56 days after DAA.

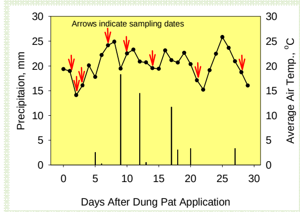


Measurements and Analyses

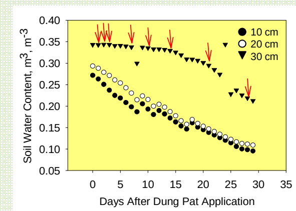
- Total N and total C extracted in water from field moist samples were quantified using Shimadzu TOC-V CPN analyzer.
- Water extractable P was determined using the molybdate method.
- KCl extractable NH4-N and NO3-N were determined using Seal high resolution analyzer.
- Soil temperature and moisture at 10 and 20 cm depths, air temperature, and precipitation were monitored continuously a weather station.
- Proc GLM model with repeated measures was employed to compare main effects and interactions.
- Multivariate analysis was used to compare nutrients outside and below dung pats within each depths.

Results

Weather and Soil Water Content - June experiment (28 DAA)



Cumulative precipitation: 57 mm.
Average air temperature: 20.3 ºC.



Water table was at 50 cm in most of the experimental plot area at 0 DAA. Decrease in water content over time was more pronounced at 10 and 20 cm depth.

Dung Beetle Colonization of dung pats

Treatment	Dung Beetles
NO BEETLE	0.5 ± 0.5 b
BEETLE	8.5 ± 1.5 a

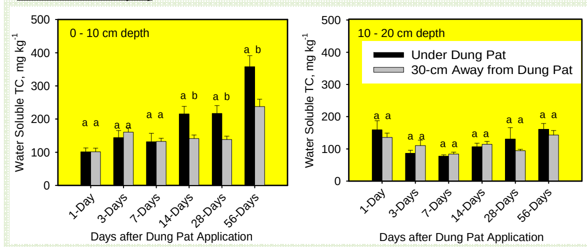
Mean ± se dung beetle number per dung pat. n=8.

At 1, 2, and 3 DAA dung beetle counts were significantly less in the NO BEETLE than in the BEETLE treatment..

Placing dung pats inside wire mesh cages effectively excluded dung beetles.

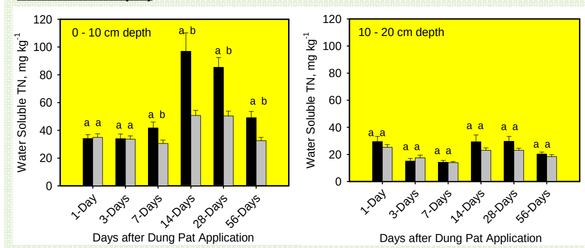
Dung beetle abundance was tested using flotation plus manual search on dung pats harvested at 1, 2, and 3 DAA

Soluble Total C (TC)



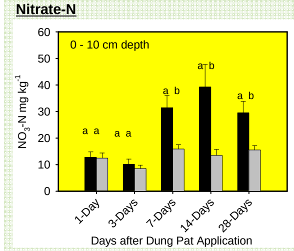
- Treatment (NO BEETLE vs. BEETLE) was not significant, however sampling location (below or away), the interactions of location by sampling times, and collection by treatment were significant.
- Beginning at 14 DAA, TC under dung pat increased and was significantly higher compared to soil away from the dung pat, indicating soluble C movement into the 0-10 cm soil depth.
- At the 10-20 cm depths, there were no significant differences directly under or away from dung pats, suggesting that within the sampling dates TC remained in the top 10cm depth.

Soluble Total N (TN)



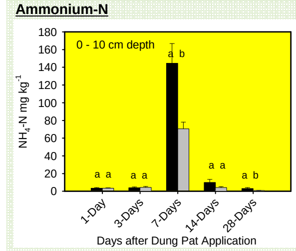
- Treatment (NO BEETLE vs. BEETLE) was not significant, however sampling location (below or away), interactions between location, and sampling time were significant.
- Unlike TC, TN under dung pat increased beginning 7 DAA, but similarly was significantly higher directly under dung pat compared to soil away from the dung pat indicating soluble N movement into the 0-10 cm soil depth.
- Precipitation between 7 days and 14 days was 33% (33 mm) of the total received for the experimental period.
- At the 10-20 cm depths, there were no significant differences directly under or away from dung pats, suggesting that within the sampling dates TN remained in the top 10 cm depth.

Nitrate-N



- Treatment (NO BEETLE vs. BEETLE) was not significant, however sampling location (below or away), interactions between location, and sampling time were significant.
- Similar to TN, nitrate-N increased beginning 7 days after dung pat application and was higher under the dung pat than away from dung pat.
- There were no differences in nitrate-N levels at 10-20 cm depth after 28 days (data not shown).

Ammonium-N



- Treatment (NO BEETLE vs. BEETLE) was not significant, however sampling location (below or away), interactions between location, and sampling time were significant.
- Ammonium was higher under dung pat only at days 7 and 28 days, although the soil both under and away from dung pat at 7-days showed high ammonium-N.

Summary and Conclusions

- Treatment designed to test the effect of dung beetles on nutrient movement was not significant. Therefore C and N between with and without dung exclusion cover were similar at both 0-10 and 10-20 cm depths.
- TC, TN, nitrate-N, and ammonium-N increase generally 7 days after dung pat application and were higher in soil under pat at 0-10 cm compared to soil away from dung pat.
- During the period between 7 and 14 DAA, 33 mm of rainfall was received. This represented approx. 1/3 of the total amount received during the experimental period.
- P levels remained approximately constant until approx. 28 and 56 DAA. No inferences could be made due to differences in the temporal scope of the experiment and the timing of P pulses.
- Contrary to some published results of effects of dung beetles on soil nutrients (Bang et al., 2005; Yamada et al., 2007) our experiments resulted in no significant difference in the magnitude and timing of peak pulses between NO BEETLE and BEETLE treatments.

Acknowledgement

This project was supported by Agriculture and Food Research Initiative Competitive Grant or National Integrated Water Quality Grant Program no. 2013-67019-21394 from the USDA National Institute of Food and Agriculture. We would like to thank Jon Soper, Heidi Hillhouse, Pat Wagner, and Torie Lindsey, for their assistance in field and laboratory work..

References

Bang, Hea Son, J. Lee, O.S. Kwon, Y.E. Na, Y.S. Jang, W.H. Kim (2005) Effects of Paracoprid Dung Beetles (Coleoptera: Scarabaeidae) On the Growth of Pasture Herbage and On the Underlying Soil. Applied Soil Ecology, Vol. 29, pp. 165-171.

Yamada, Daigo, O. Imura, K. Shi, T. Shibuya (2007) Effect of Tunneler Dung Beetles On Cattle Dung Decomposition, Soil Nutrients, and Herbage Growth. Japanese Society of Grassland Science, Vol. 53, pp. 121-129.